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# *i*-STS

## Modbus Interface User Manual

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## DOCUMENT HISTORY

12/11/2004	<b>Version 1.0</b>  Original Specification for MODBUS monitoring of Static Power PTY LTD STS units. Based on Modicon MODBUS specification . <i>Author, Michael A. Tynkkynen.</i>
16/12/2004	<b>Version 1.1</b>  Added Status Bit definitions for monitoring of Shorted/Open SCR's and Trip status of Breakers. <i>Author, Michael A. Tynkkynen.</i>
20/04/2005	<b>Version 1.2</b>  Corrected Serial Flow Control setting. Amended register map for second source frequency entry. <i>Author, Michael A. Tynkkynen.</i>
28/02/2011	<b>Version 1.3</b>  Added detail for Modbus TCP. <i>Author, Michael A. Tynkkynen.</i>
12/11/2014	<b>Version 1.4</b>  Corrected Modbus TCP/IP Port <i>Author, Lucas Chenco.</i>
07/05/2015	<b>Version 1.5</b>  Updated Modbus TCP/IP Request <i>Author, Lucas Chenco.</i>

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# INTRODUCTION

*i*-STS has support for the Modicon MODBUS protocol to access operating data of the STS units. The protocol is adhered to as much as possible, though there are a few changes.

Only the relevant function codes have been represented, and within that packet structure may be changed based on the usage. These minor changes have been documented fully in this document.

This document details in their own sections:

- Transport and framing of the MODBUS packets,
- The data units of the general MODBUS packet,
- The implemented MODBUS function codes and their packet structure (both requests and responses),
- And the Addressable Registers.

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## TRANSPORT AND FRAMING

There are three main transport mechanisms for MODBUS; Serial ASCII, Serial RTU and TCP/IP. This document describes only the Serial RTU and TCP transport methods.

Serial parameters are:

- 2400 Baud.
- 8 Data Bits.
- 1 Stop Bit.
- No Parity.
- No Flow Control.

Note that the serial port does not provide electrical isolation. Care should be exercised in respect to communications grounding techniques.

The implementation is suitable for use in a RS485/RS422 multi-drop scheme in that the STS will not respond (with Neg Ack) to requests intended for other addressees.

Framing is handled via timing. Each MODBUS packet is delimited by a 'silent' time of 3.5 characters. Concatenation of data is expected to occur for any interval shorter than the specified time. The silent time with the specified serial parameters is approximately 12 milliseconds.

NOTE that all multi-byte values, such as 16 bit register addresses, are transported in the standard MODBUS manner; the most significant byte precedes the less significant byte.

For Modbus TCP, connect through port **502**.

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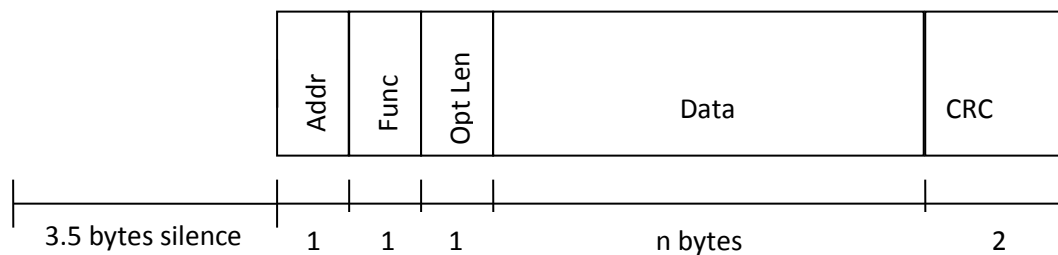
## DATA UNITS

### MODBUS RTU

The typical MODBUS RTU packet is as follows.

- 1 Byte Modbus Address
- 1 Byte Function Code
- (1 Byte representing byte count of n bytes, depending on whether the function code implies fixed length data or not)
- n Bytes Data
- 2 Bytes CRC

The specific function codes and their respective packets are described in the next section.



### MODBUS TCP

The typical MODBUS TCP packet is as follows.

- 2 Bytes Transaction ID. Unit reflects this back to sender.
- 2 Bytes Protocol. This is just zero and is ignored by unit.
- 2 Bytes Length. The total length of Modbus frame.
- 1 Byte Unit Id. Unit ignores this. Units are identified uniquely by IP address.
- 1 Byte Function Code
- 2 Bytes Register address
- 2 Bytes Number of registers (max 10)

Note in all subsequent data descriptions only detail the function code and data components. Transport mechanism wraps packet as described here.

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## FUNCTION CODES

The function codes from the MODBUS protocol that are implemented in the STS units are highlighted in the following table.

Function Code	Purpose	Supported
01	Read Coil	No
02	Read Input Status	No
03	Read Holding Registers	Yes
04	Read Input Registers	No
05	Force Single Coil	No
06	Preset Single Register	Yes
07	Read Exception Status	No
08	Diagnostics	No
09	Program 484	N/A
10	Poll 484	N/A
11	Fetch Comm Event Counter	Yes
12	Fetch Comm Event Log	Yes
13	Program Controller	N/A
14	Poll Controller	N/A
15	Force Multiple Coils	No
16	Preset Multiple Registers	No
17	Report Slave ID	Yes
18	Program 884/M84	N/A
19	Reset Comm Link	No
20	Read General Reference	No
21	Write General Reference	No
22	Mask 4x Register	No
23	Read/Write 4x Registers	No
24	Read FIFO Queue	No

Note, that waiting more than 3.5 characters in time before sending implies a reset of communications, as the slaves only respond to requests. Any malformed packet returns an error packet and will reset to awaiting data again.

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## FUNCTION PACKET STRUCTURES

### ERROR INDICATION RESPONSE

Any packet that has an error will receive a response as follows:

1 Byte Error Code

The Error Code will be one of the following.

- 0x80 Bad CRC
- 0x81 Bad Function Code
- 0x82 Illegal Address
- 0x83 Illegal Data
- 0x84 Slave Failure

### READ HOLDING REGISTERS

Reads the specified range of registers and reports them back to the master. Full list of available registers detailed in the next section. Note: a maximum of 10 registers can be retrieved at a time.

- 1 Byte Function Code (0x03)
- 2 Bytes Starting Address
- 2 Bytes Number of Registers

Response is as follows

- 1 Byte Function Code (0x03)
- 1 Byte Byte Count (represents 2n registers)
- 2n Bytes Register Values

### FETCH COMM EVENT COUNTER

1 Byte Function Code (0x0B)

The response indicates how many events are held in the event log of the STS. The internal event log, contains memory for up to the last 100 events. The oldest events are overwritten.

The status field has been kept so as to adhere to the MODBUS protocol as much as possible, though it will only contain 0's.

- 1 Byte Function Code (0x0B)
- 2 Bytes Status (0x0000)
- 2 Bytes Event Count



## FETCH COMM EVENT LOG

This function also deviates from the original MODBUS specification due to the nature of the STS's internal logging method.

Events can be retrieved from the device via other methods, so events will NOT be removed by reading them via the MODBUS interface.

A maximum of 10 events can be retrieved in one request. If a number of events requested is greater than 10, only 10 will be returned.

If there are fewer events in the log than the requested amount, then only the available number of events will be returned.

Each event occupies 6 bytes, so the total number of events returned is Byte Count divided by 6.

- 1 Byte Function Code (0x0C)
- 1 Byte Number of First Event of Interest
- 1 Byte Number of events.
  
- 1 Byte Function Code
- 1 Byte Byte Count (n events x 6):
  - 4 Bytes Time Stamp
  - 1 Byte Event Type
  - 1 Byte Event Result / Target

Note that the Time Stamp is a 32 bit value indicating the seconds since 00:00:00, 1 January 2003. Event Types and messages in can be found in the Appendix.

## REPORT SLAVE ID

This function deviates from the Modicon MODBUS version of the same function. This is the only supported function that will allow broadcast.

Not available in Modbus TCP.

- 1 Byte Broadcast Address (0x00)
- 1 Byte Function Code (0x11)
- 2 Bytes CRC

Response is the same packet echoed, but with the Broadcast Address replaced with the Slave Address.

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## REGISTER MAP

Note, the notation (x100) indicates that the value has been multiplied by decimal 100 to avoid floating point. Likewise, (x10) indicates scaling by 10.

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## WRITABLE REGISTERS

Register Address Range: 0x01XX

Address	Label
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0x100	Transfer. A Value of 1 to Supply 1, 2 to Supply 2. Other values return error.
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## READABLE REGISTERS

### SUPPLY PARAMETERS

Register Address Range: 0x02XX

Address	Label
0x200	Active Supply
0x202	Supply 1 Frequency. (x10)
0x204	Supply 2 Frequency. (x10)
0x206	Sync
0x208	Neutral Current
	Supply Parameters, and if three phase, Red phase values.
0x210	Supply 1 Voltage.
0x212	Supply 2 Voltage.
0x214	Output Voltage.
0x216	Output Current. (x10)
0x218	kVA. (x10)
0x21A	kW. (x10)
0x21C	Power Factor. (x100)
0x21E	Crest Factor I. (x10)
0x220	THDI. (x100)
0x222	THDV. (x100)
	White phase parameters, available only if three phase.
0x230	White Supply 1 Voltage.
0x232	White Supply 2 Voltage.
0x234	White Output Voltage.
0x236	White Output Current. (x10)
0x238	White kVA. (x10)
0x23A	White kW. (x10)
0x23C	White Power Factor. (x100)
0x23E	White Crest Factor I. (x10)
0x240	White THDI. (x100)
0x242	White THDV. (x100)
	Blue phase parameters, available only if three phase.
0x250	Blue Supply 1 Voltage.
0x252	Blue Supply 2 Voltage.
0x254	Blue Output Voltage.
0x256	Blue Output Current. (x10)
0x258	Blue kVA. (x10)
0x25A	Blue kW. (x10)
0x25C	Blue Power Factor. (x100)
0x25E	Blue Crest Factor I. (x10)
0x260	Blue THDI. (x100)
0x262	Blue THDV. (x100)

## OPERATING STATES

Register Address Range: 0x03XX

*Note: Bit 0 indicates the least significant bit, and each bit set indicates that the statement is true. Any reserved value will contain 0.*

Address	Label
0x300	User Relay Status Bit 0: General Alarm. Bit 1: Not synchronised. Bit 2: Supply 1 fault. Bit 3: Supply 2 fault. Bit 4: On supply 1 Bit 5: On supply 2 Bit 6: Overload warning. Bit 7: Reserved. Bit 8: Remote transfer inhibit. Bit 9: Remote transfer alternate. Bit 10: Remote power off. Bits 11-12: Reserved. Bit 13: Remote power off disabled. Bit 14: Low current. Bit 15: Sync Loss.
0x302	System Status * Bit 0: Output stopped manually. Bit 1: Output stopped fault. Bit 2: Output stopped remotely. Bit 3: Front panel reset. Bit 4: Front panel transfer request. Bit 5: Transfer in progress. Bit 6: Delayed transfer in progress. Bit 7: Output overcurrent. Bits 8-14: Reserved. Bit 15: Summary Alert.
0x304	Mode Operating Status * Bits 0-7: Reserved Bit 8: Remote IO mode. Bit 9: Standalone mode. Bit 10: Parallel mode. Bit 11: Parallel redundant mode. Bit 12: Three phase three wire mode. Bit 13: Three phase four pole mode. Bits 14-15: Reserved.
0x306	Ventilation Status * Bit 0: Internal temperature high. Bit 1: Magnetism temperature high. Bit 2: Bithermal 1 temperature high. Bit 3: Bithermal 2 temperature high. Bits 4-6: Reserved. Bit 7: Fan failure.

	Bits 8-15: Reserved.
0x308	Breaker Status. * Bit 0: Reserved. Bit 1: Q5 closed. Bit 2: Q4 closed. Bit 3: Q3 closed. Bit 4: Q2 closed. Bit 5: Q1 closed. Bit 6: Reserved. Bit 7: Q5 Tripped. Bit 8: Q4 Tripped. Bit 9: Q3 Tripped. Bit 10: Q2 Tripped. Bit 11: Q1 Tripped. Bits 12-15: Reserved.
0x30A	Lan Status (only with LAN option) Bit 0: Using Default IP. Bits 1 – 15: Reserved.
0x30C	Diagnostic Status 1. * Bits 0-8: Internal Comms error. Bits 9-15: Reserved.
0x30E	Diagnostic Status 2. * Bits 0-2: Reserved. Bit 3: Low power mode – CPU supply power failure. Bits 4-7: Reserved. Bit 8: Watchdog Timer timeout. Bit 9: Warm start. Bit 10: Cold start. Bit 11: Reserved. Bit 12: Stack Overrun. Bit 13-14: Reserved. Bit 15: ROM checksum error.
0x310	SCR Status * Bit 0: Red Supply 1 SCR Short Circuit Bit 1: Red Supply 1 SCR Open Circuit Bit 2: Red Supply 2 SCR Short Circuit Bit 3: Red Supply 2 SCR Open Circuit Bit 4: White Supply 1 SCR Short Circuit Bit 5: White Supply 1 SCR Open Circuit Bit 6: White Supply 2 SCR Short Circuit Bit 7: White Supply 2 SCR Open Circuit Bit 8: Blue Supply 1 SCR Short Circuit Bit 9: Blue Supply 1 SCR Open Circuit Bit 10: Blue Supply 2 SCR Short Circuit Bit 11: Blue Supply 2 SCR Open Circuit Bit 12: Neutral Supply 1 SCR Short Circuit Bit 13: Neutral Supply 1 SCR Open Circuit Bit 14: Neutral Supply 2 SCR Short Circuit Bit 15: Neutral Supply 2 SCR Open Circuit

*\*Indicates that the register contains no meaningful information in Modbus TCP.*

## UTILISATION DETAILS

Register Address Range: 0x04XX

Address	Label
0x400	Hours on Supply 1.
0x402	Hours on Supply 2.
0x404	Hours on Preferred Supply.
0x406	Number of Forced Transfers.
0x408	Number of Sync Losses.
0x40A	Number of Load Faults.
0x40C	Number of Outages.
0x40E	Timestamp of last fault High. See note below.
0x410	Timestamp of last fault Low. See note below.
0x412	Timestamp of last outage High. See note below.
0x414	Timestamp of last outage Low. See note below.

Note that the Timestamp values are 32 bit registers. The two 16 bit registers need to be strung together to form a 32 bit number of seconds since 00:00:00, 1 January 2012.

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## APPENDIX

### EVENT TYPES

Boot	0	Transfer	25
Initialise	1	Low Power Mode	26
Watchdog	2	Current	27
Stack	3	Manual Bypass	28
Blank Index	4	Preference	29
EEPROM	5	Varf	30
ROM	6	Total Harmonic Distortion Current	31
Battery	7	Total Harmonic Distortion Voltage	32
Communications	8	Ambient	33
Calibration	9	Magnetics	34
Supply 1 Average	10	Heat-sink	35
Supply 1 Transient	11	Fan	36
Supply 1	12	Thermal	37
Frequency	13	Debug	38
Sync	14	Remote Power	39
Supply 2 Average	15	Remote Transfer Request	40
Supply 2 Transient	16	Local Transfer Request	41
Supply 2	17	Blank	42
On	18	Breaker Open	43
Off	19	Breaker Closed	44
Force	20	Tripped	45
Supply 3	21	Thyristor Short circuit	46
Overload	22	Thyristor Open circuit	47
Load	23	Alarm Cancel	48
Fail	24	Power Supply	49
Transfer	25	Back Feed	50

## EVENT MESSAGES

0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
None	10
Ok	11
High	12
Low	13
Fault	14
Clear	15
Loss	16
Warn	17
On	18
Off	19
Timer	20
Red One	21
Red Two	22
White One	23
White Two	24
Blue One	25
Blue Two	26
Neutral One	27
Neutral Two	28
Red	29
White	30
Blue	31





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Post to:  
Box 2003  
Research Delivery Centre  
Research VIC 3095  
Australia

Manufactured at:  
5 Candlebark Court  
Research VIC 3095  
Australia

Phone: +613 9437 0494  
Fax : +613 9437 0939  
Email : [sales@i-sts.com.au](mailto:sales@i-sts.com.au)  
Web : [www.i-sts.com.au](http://www.i-sts.com.au)

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